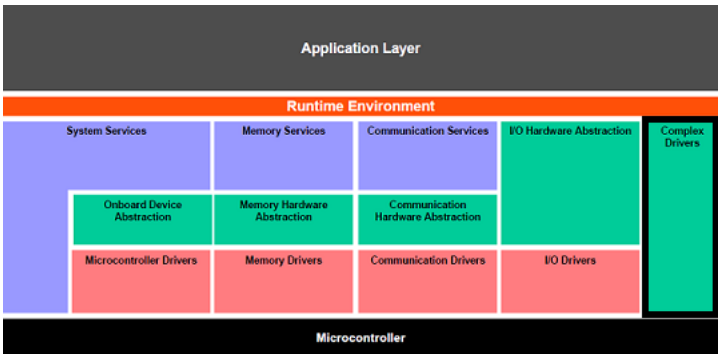
Cdd IPC Design Document

Introduction

Overview

The figure below depicts the AUTOSAR layered architecture as 3 distinct layers, Application, Runtime Environment (RTE) and Basic Software (BSW). The BSW is further divided into 4 layers, Services, Electronic Control Unit Abstraction, MicroController Abstraction (MCAL) and Complex Drivers.

MCAL is the lowest abstraction layer of the Basic Software. It contains software modules that interact with the Microcontroller and its internal peripherals directly. Inter Processor Communication (IPC) driver is part of the Complex Device Driver (block, show above). Below shows the position of the CDD IPC driver in the AUTOSAR Architecture.



AUTOSAR Architecture – CDD IPC MCAL

- Module ID shall be 255
- Vendor ID shall be 44
- Instance ID shall be 0

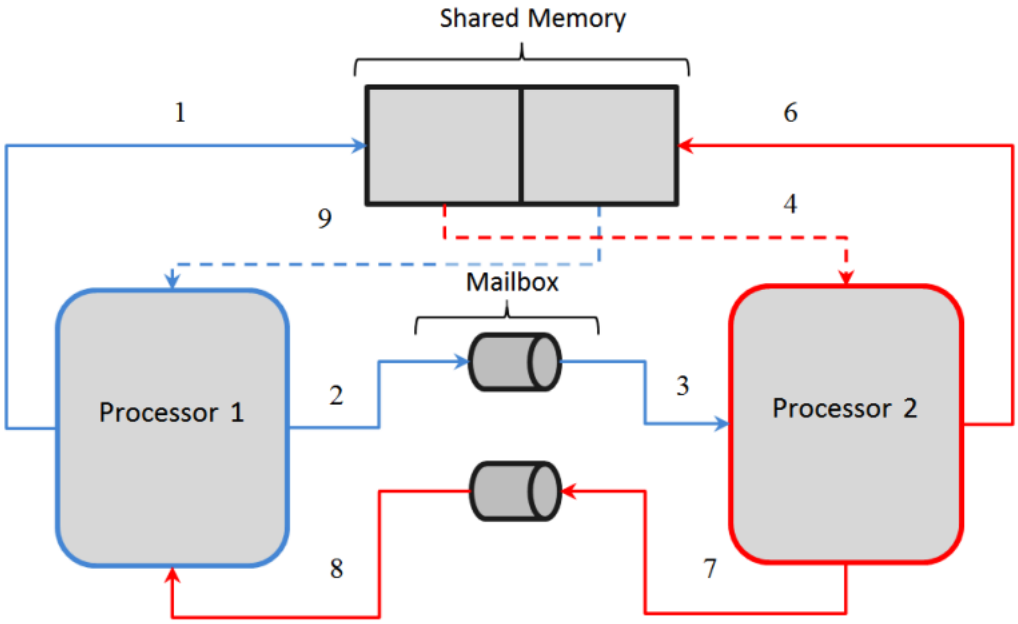
Cdd IPC Overview

CDD IPC primarily used for communication with other cores on the SoC. This implementation relies on mailbox and shared memory to establish communication channel.

Shared memory holds the messages that requires to be transported and mailbox is used to notify the remote core on availability of a message.

Basic Working Principle

Table of Contents



CDD IPC MCAL - Basic Working Principle

Transmission & Reception

Transmission of message from 1 processor to another is performed by 4 step sequence. As depicted above

- Processor 1 has to send a message of 128 bytes to Processor 2

1. Processor 1 copies the message to shared area, designated write area to this processor
2. Writes a pre-determined pattern to mailbox
3. Processor 2, receives an interrupt indicating presence of a message in Processor 1, designated write area.
4. Processor 2, read the data from shared area
5. Processor 2, processes the received message and has to reply back with different message
6. Processor 2 copies the message to shared area, designated write area to this processor
7. Writes a pre-determined pattern to mailbox
8. Processor 1, receives an interrupt indicating presence of a message in Processor 2, designated write area.
9. Processor 1, read the data from shared area
10. Processor 1, processes the received message

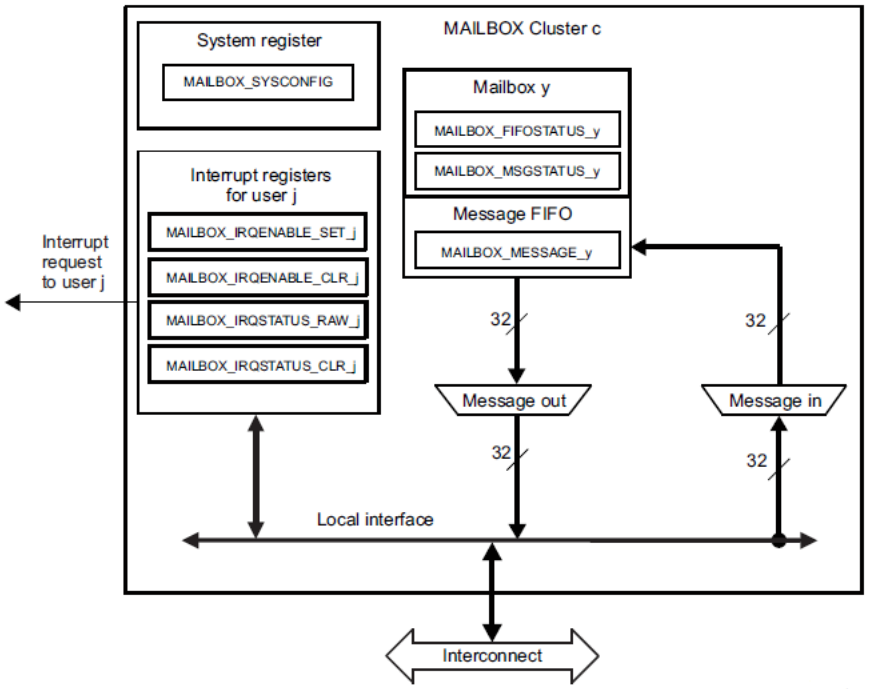
- **Note that dotted line indicates a READ-ONLY operation**

Mailbox hardware

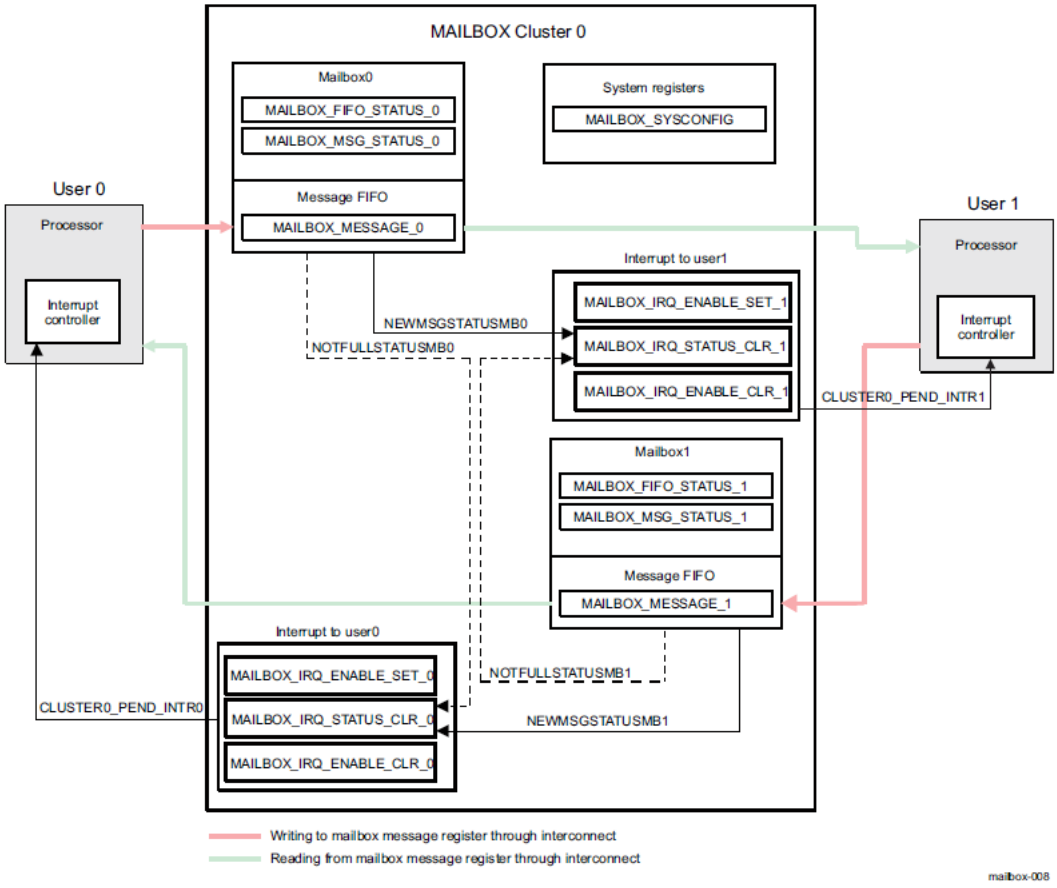
Communication between the on-chip processors of TDAxx class of devices uses a queued (FIFO) mailbox-interrupt mechanism. The queued mailbox-interrupt mechanism allows the software to establish a communication channel between two processors through a set of registers and associated interrupt signals by sending and receiving messages. Mailbox could be envisioned as shared FIFO between cores and can generate an interrupt either on reception of a 32 bit word or on FIFO not being empty.

Below shows the block diagram of the Mailbox IP, FIFO (referred as FIFO ID, throughout this document) could be used to write and read messages. The depth of the FIFO depends on the SOC used and an interrupt could be generated either on reception of a 32 bit word or on FIFO not being empty. These interrupts could be routed to any of the cores (refer device specific TRM for restrictions, not all mailboxes interrupts could be routed to all cores)

Mailbox Block Diagram



Mailbox Block Diagram



Example of Communication between 2 cores

It's important to note that the Mailbox hardware shall not be reset, as there could be pending messages in the FIFO. Other entities (such as boot-loader, start up sequence would have reset the mailbox)

Design ID	DES_CDD_IPC_001
Requirements	MCAL-3707

Rational for IPC as an CDD

TDAxxx class of processors has multiple processing cores (such as DSP's, ARM (A7, R5F), etc.…) and AUTOSAR stack is not hosted on all of these cores (i.e. heterogeneous system with one or more OS's) and AUTOSAR doesn't define standardized entity for inter-core communication in a heterogeneous multi-core systems. Hence a CDD is implemented to provide communication mechanism between cores via Mailbox (peripheral for inter-processors communication mechanism) and shared memory.

References

Sl No	Specification	Comment / Link
1	AUTOSAR 4.2.1	CDD Design & Integration Guideline Intranet Link
2	AM65XX and TDA4x TRM	Technical Reference Manual, Mailbox module is detailed
3	BSW General Requirements / Coding guidelines	Intranet Link
4	Software Product Specification (SPS)	Intranet Link Requirements are derived from **1** & **2**

Requirements

The CDD IPC driver shall implement as per requirements detailed in **4**, **1** and **2**. It's recommended to refer **1** for clarification.

Back To Top

Features Supported

Below listed are some of the key features that are expected to be supported

- Ability to transport fixed messages across cores
- Notify on reception of message from remote core
- Received messages are retained within the driver until consumed by applications
  - i.e. Messages will not be available in the new message notification ISR. Service API call required to receive the message
  - Number of messages that can be queued is configurable
- Configureable maximum message size
- Ability to announce capability of core to all other cores
- PRE COMPILE Variant is supported

Design ID	DES_CDD_IPC_002
Requirements	MCAL-964, MCAL-3717, MCAL3691, MCAL-3724, MCAL-3682, MCAL-3685, MCAL-3730, MCAL-3708, MCAL-920 MCAL-3703

Back To Top

Features Not Supported

- Non use of shared memory for message length <= 32bits
  - Always uses shared memory irrespective of the message length
- Configureability to use different mailbox, user id, FIFO ID & cluster
  - Mailbox, user id, FIFO ID and cluster instance is built into driver, that guranteens inter-interoperability with TI IPC drivers
- VARIANT-POST-BUILD and VARIANT-LINK-TIME Variants are not supported

Design ID	DES_CDD_IPC_003
Non Requirements	MCAL-3708, MCAL-3709, MCAL-3710

Back To Top

Assumptions

Below listed are assumed to valid for this design/implementation, exceptions and other deviations are listed for each explicitly. Care should be taken to ensure these assumptions are addressed.

1. **This design assumes that TI IPC driver are used in the remote cores**
2. **The shared buffer shall be allocated in non-cached region and accessible to all cores participating in IPC**
3. The functional clock to the Mailbox module is expected to be on before calling any CDD IPC service APIs
4. The CDD IPC driver as such doesn't perform any PRCM programming to get the functional clock
5. Configurator : This design do not depend on the configurator used. Use of EB Configurator is recommended as other MCAL modules use the same.

Design ID	DES_CDD_IPC_004
Non Requirements	MCAL-3699, MCAL-3675, MCAL-921

Back To Top

Constraints

Some of the critical constraints of this design are listed below

- The communication channels are created statically, via the configurator
  - i.e. Remote end points of the remote core will have to defined and CDD IPC configurations generated before compilation.
- Reserved END POINT, CDD IPC will reserve one of the end point which shall be be used to communicate control messages. Control endpoint would 53 Refer **API**,

Design ID	DES_CDD_IPC_005
Requirements Covered	MCAL-3677, MCAL-3678, MCAL-3679, MCAL-3680, MCAL-3681, MCAL-3682, MCAL-3685, MCAL-3686, MCAL-3760

Back To Top

Design Description

As detailed in **Overview**, IPC relies on shared memory & mailbox to transmit and receive messages. Section below highlight some of the key concepts.

Shared Memory

As discussed in **Basic Principle**, shared memory is required for IPC. This shared memory region shall be referred as **VirtIo**

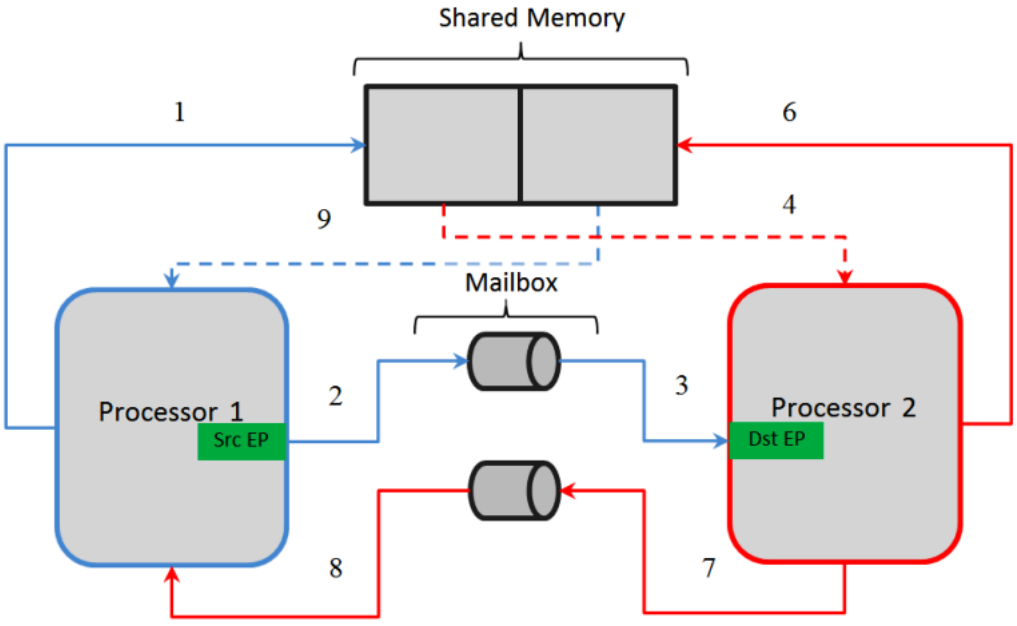
Processor Identifiers

In order to be able to communicate with multiple cores, each cores requires to be identified uniquely. Refereed as **procId** in the rest of this document.

The configurator shall allow integrators to select set of cores, with which communication is desired.

End Point

To allow multiple logical channels for communications an end-point shall be used. The end-point shall be an unsigned integer configurable through the configurator, with the exception of reserved end point. Refer **Constraint End Point** for details



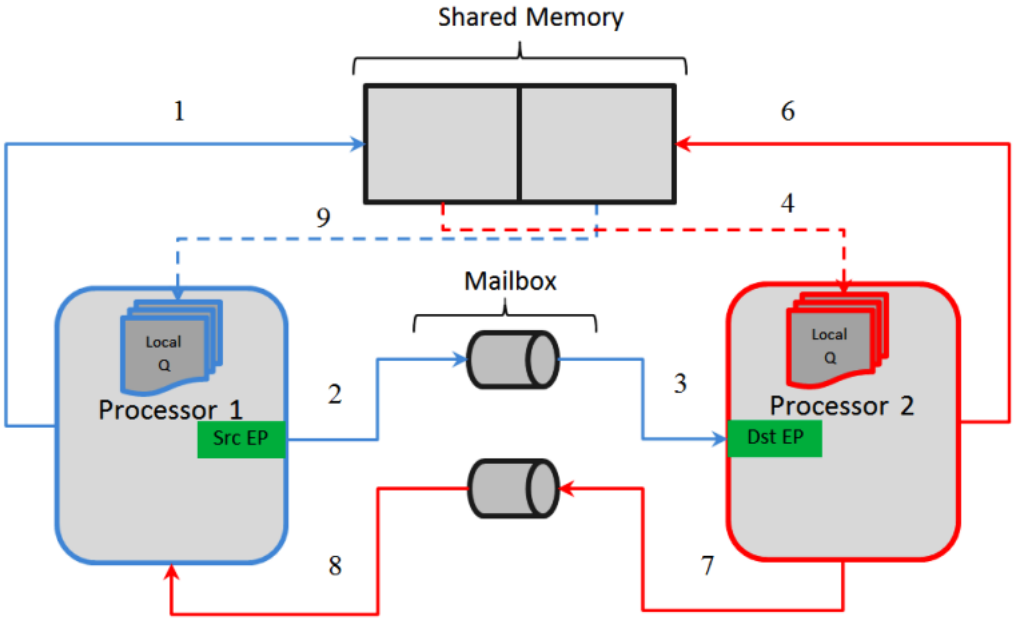
Need of End-Point in communication

Design ID	DES_CDD_IPC_006
Requirements Covered	MCAL-3672, MCAL-3673, MCAL-3674, MCAL-3675, MCAL-3676, MCAL-3668, MCAL-3669, MCAL-3670, MCAL-3671, MCAL3679, MCAL-3680, MCAL-3681

Back To Top

Message Buffer

Referring the diagram below, Processor 1 reads from Processor 2 designated write area and vice versa. To prevent loss of messages (in cases where the receiving processor was slower/loaded with other high priority tasks) the message is copied into local queue. When service API to receive is invoked, the received message from the queue is copied into user provided buffer. Please note that, these copies are CPU based copies.



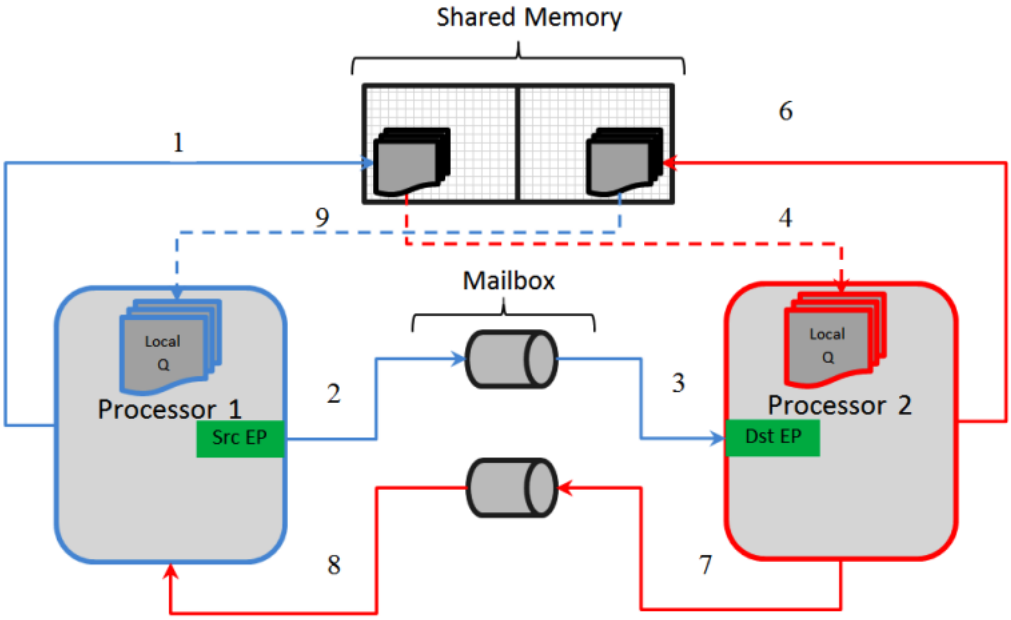
Need for Queue to store received messages

Design ID	DES_CDD_IPC_007
Requirements Covered	MCAL-3682, MCAL-3674, MCAL-3755

Back To Top

Queue in shared memory

It could be possible that one processor (producer) might generate faster IPC messages than another processor (consumer). To avoid messages being over-written/lost an shared queue shall be implemented in the shared buffer, as depicted in the diagram below



Shared Queue

Some of the key points to note, considering the above example

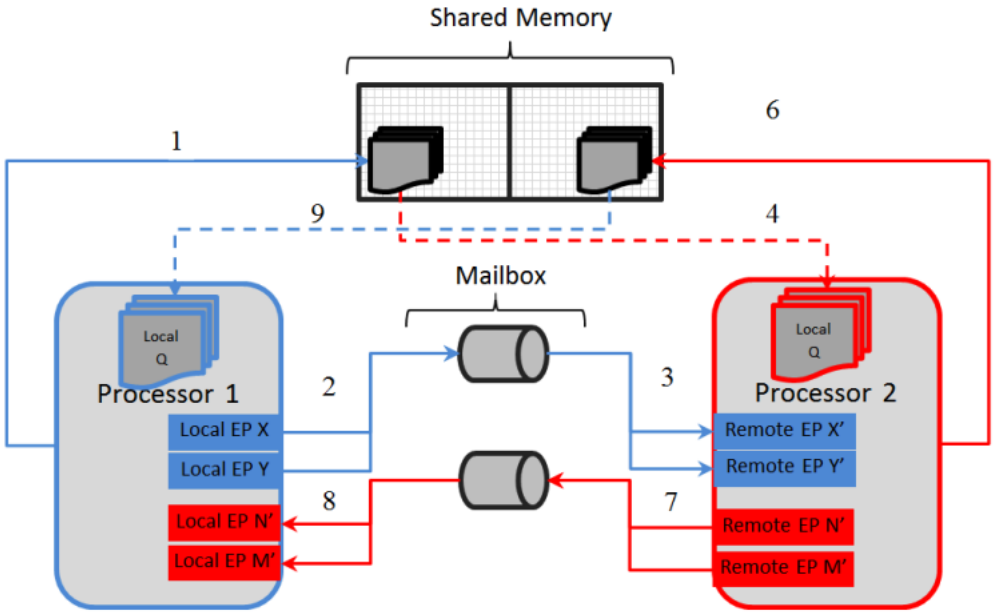
- The queue implemented in Processor 1 designated shared area
  1. The queue shall be circular queue
  2. The writer (Processor 1, in this e.g.) shall write and advance write-pointer only
  3. The reader (Processor 2, in this e.g.) shall read and advance read-pointer only
  4. The actual message shall be stored in the designated shared area and queue element shall contain a pointer to the message.

Design ID	DES_CDD_IPC_008
Requirements Covered	MCAL-3673, MCAL-3674

Back To Top

Multiple End Point / Communication Channels

IPC CDD shall provide ability to create multiple end-point pairs. As depicted in the diagram below, applications could define multiple end-point pairs to realize multiple communication channels



Multiple End Points

Some of the key points to note, considering the above example

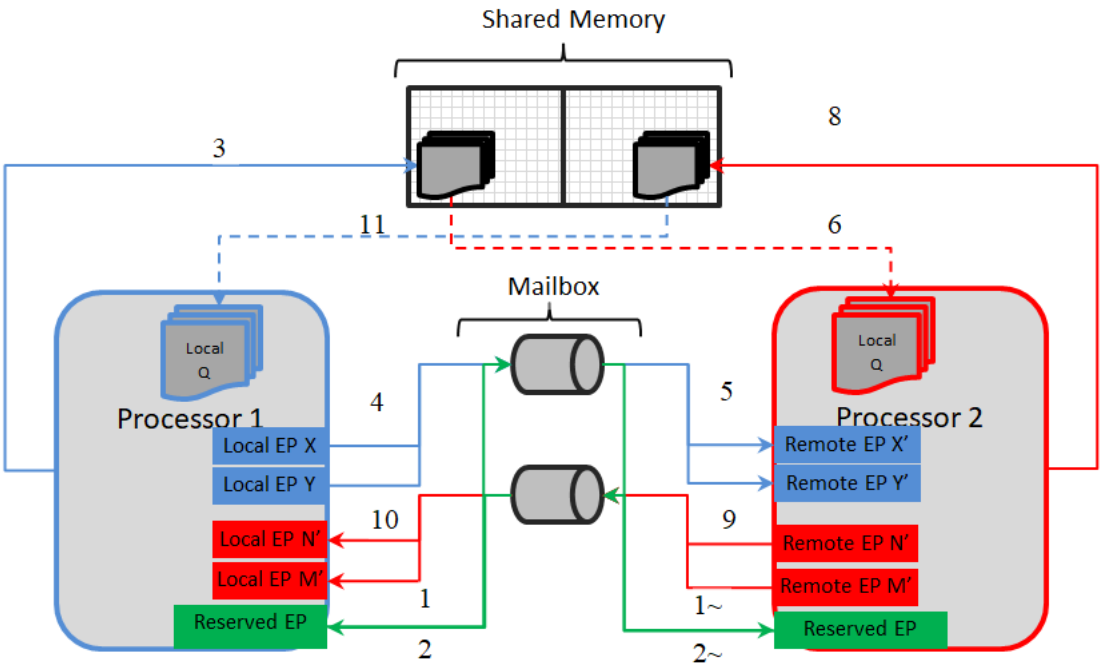
- From the perspective of *Processor 1*
  1. Local End Points (Local EP X, Y, M & N) define end-points on Processor 1
  2. Remote End Points (Remote EP X', Y', M' & N') define end-points on Processor 2
  3. End-point pairs (X and X', Y and Y', M and M' & N and N') define 4 distinct communication channels
  4. End-point pairs X and X', Y and Y' are used to transmission of messages from Processor 1 to Processor 2
  5. End-point pairs M and M', N and N' are used to reception of messages from Processor 2 to Processor 1
  6. Note that X & X' could be same and shall be honored.

Design ID	DES_CDD_IPC_009
Requirements Covered	MCAL-3685

Back To Top

Control End Point

IPC CDD shall create a **control end point** primarily used for communication of control messages. This shall be created by default, provided **CddIpcAnnounceApi** is ON



Control End Points

Some of the key points to note, considering the above example

- From the perspective of *Processor 1*
  1. Control end point shall be used to announce availability of a remote end point to processes messages
  2. Shall allow transportation of n bytes of data
  3. Shall not be bound to user defined end point
  4. Shall rely on **Reserved END POINT**

A Typical sequene would be, assuming Processor 1 start first followed by Processor 2

Time	Processor 1	Processor 2
T1	Annouce Availability of end points - Step 1	Not Yet Started
T2	Wait for control message - Step 2	Not Yet Started
T3	Waiting	Annouce Availability of end points - Step ~1
T4	Validate Control message	Wait for control message - Step ~2
T5	Trasmit/Receive message	Validate control message
T6	Trasmit/Receive message	Trasmit/Receive message

Design ID	DES_CDD_IPC_037
Requirements Covered	MCAL-4068, MCAL-4069

Back To Top

Dynamic Behavior

States

CDD IPC shall maintain two distinct states **Initialized** & **Un Initialized**

Initialized State <====> Un Initialized State

- **Initialized State**
  - All service API's shall be honored
  - All configured communication channels created
  - Shall be able to receive messages from configured remote core on configured end-point.
- **Un Initialized State**
  - All service API's shall NOT be honored, Refer **API**
  - Any service API invoked shall return CDD_IPC_E_INIT_FAILED

Design ID	DES_CDD_IPC_010
Requirements Covered	MCAL-3706, MCAL-3715, MCAL-3756

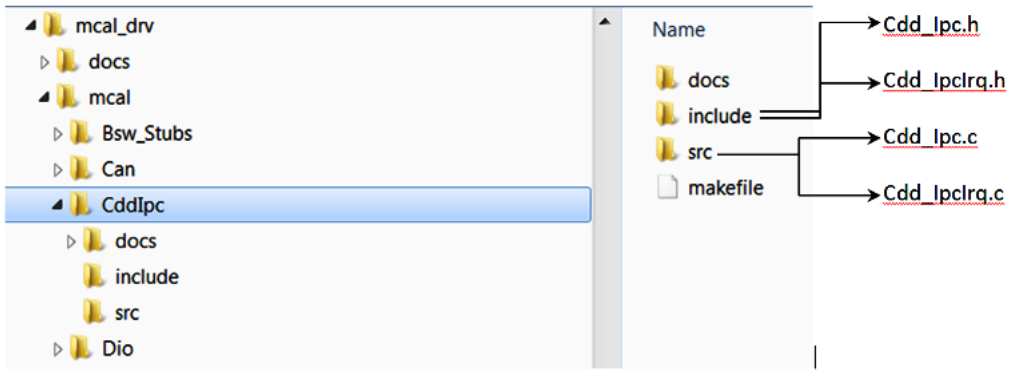
Back To Top

Directory Structure

The directory structure is as depicted in figures below, the source files can be categorized under “Driver Implementation” and “Configuration”

Driver Implemented by

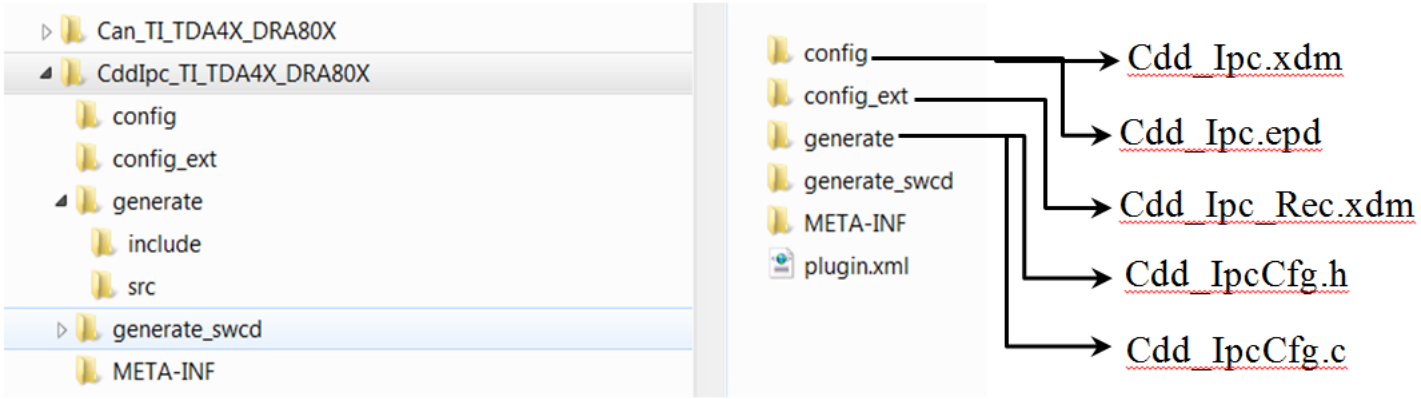
- Cdd_Ipc.h and Cdd_IpcIrq.h: Shall implement the interface provided by the driver
- Cdd_Ipc.c, Cdd_IpcIrq.c : Shall implement the driver functionality
- **Cdd_IpcCbk.h** : Shall define function prototype that shall be implemented by the applications and invoked by the driver on reception of new message.



IPC CDD Directory Structure

Configuration

- Standard EB configuration structure



Configurator Plugin Directory Structure

Back To Top

Configurator

TI specific parameters are detailed in following sections and Standard AUTOSAR parameters are not detailed.

Design ID	DES_CDD_IPC_011
Requirements Covered	MCAL-921, MCAL-964

Following lists this design’s specific configurable parameters

CDD IPC General Configuration parameters

Parameter	Usage comment
CddIpcOSCounterId	This shall allow integrators to specify the OS counter instance to be used in OS API GetCounterValue () The driver shall implement timed-wait for all waits (e.g. waiting for reset to complete). This timed wait shall use OS API GetCounterValue ()

CddIpcDeviceVariant	This shall allow integrators to select the device variant for which integration is being performed. This parameter shall be used by driver to impose device specific constraints. The user guide shall detail the device specific constraints
CddDevErrorDetect	This parameter turns on ERROR detection and shall be used during development, disabled for production builds
NewMsgNtfyFunc	Specify the integrator defined function that would invoked on reception of new message
CddVersionInfoApi	Enable / Disable Get Version Info service API
CddDeinitApi	Enable / Disable De Initialization of IPC CDD service API
CddIpcAnnounceApi	Enable / Disable Announcement (broadcast) of processors capabilities to other cores. This service API would be mandatory when the remote core hosts Linux
CddRegisterReadBackApi	Enable / Disable service API to Read back of critical registers
CddIrqType	Specify category of ISR, Only CAT 2 is supported

Design ID	DES_CDD_IPC_012
Requirements Covered	MCAL-3694, MCAL-980, MCAL-3693, MCAL-3691, MCAL-3690, MCAL-3688, MCAL-3689, MCAL-3687, MCAL-3692, MCAL-3696

Back To Top

CDD IPC Shared Memory Configuration parameters

Parameter	Usage comment
VertIoRingAddr	Specify the physical address of the shared memory. [Constraints] Please refer (**Constraints**) & (**Cdd IPC Overview**)
VertIoRingSize	Please retain the recommended configurations. When changing, ensure the size is same across all cores that uses IPC.
VertIoObjSize	Non shared memory, used for book-keeping of VRING. Refer **LocalQ**. Note that memory shall be allocated in the generate configuration and alignment to 128 byte boundary shall be ensured.
reserved	Reserved for future use

Design ID	DES_CDD_IPC_013
Requirements Covered	MCAL-3674, MCAL-3675, MCAL-3676

CDD IPC Processor Identifier

Parameter	Usage comment
OwnProcID	Select the current processor on which the MCAL/AUTOSAR is hosted

Design ID	DES_CDD_IPC_014
Requirements Covered	MCAL-3668, MCAL-3669, MCAL-980

Back To Top

CDD IPC Processor Identifier Remote

Parameter	Usage comment
ProcID	Select the list of remote processor ID, which with IPC is desired. Please note that all selected remote processors shall host TI IPC

Design ID	DES_CDD_IPC_015
Requirements Covered	MCAL-3671

CDD IPC Communication Channels

Parameter	Usage comment
CommId	Specify an unique integer that uniquely identifies the communication channel. This ID shall be used in service API's to transmit/receive/notify arrival on new message. Configurator shall support symbolic names for the communication ID's
LocalEp	Local End Point, specify an unique integer that uniquely identifies the communication channel end-point on a given processor. The reserved end-point shall not be accepted by the configurator
RemoteEp	Remote End Point, specify an unique integer that uniquely identifies the communication channel end-point on a associated remote processor. The reserved end-point shall not be accepted by the configurator
RemoteProcID	Remote processor, shall be one of the processor listed in (**CDD IPC Processor Identifier Remote**)
MaxNumMsgQueue	Specify the maximum number of messages that can queued (before received by call to receive service API) (**Message Buffer**)
MaxMsgSize	Specify the maximum size of all possible messages that could be received. (before received by call to receive service API) (**Message Buffer**)

- The driver shall reserves space to implement a queue of elements and the size shall be **MaxNumMsgQueue * MaxMsgSize bytes** .

Design ID	DES_CDD_IPC_016
Requirements Covered	MCAL-3677, MCAL-3678, MCAL-3679, MCAL-3680, MCAL-3681, MCAL-3682, MCAL-3685, MCAL-3686, MCAL-3755, MCAL-3686

Back To Top

Variant Support

The driver shall support VARIANT-PRE-COMPILE only

Design ID	DES_CDD_IPC_017
Requirements Covered	MCAL-3703

Back To Top

Dependency on other modules

CDD IPC driver shall depend on these modules to realize the required functionality.

- Standard BSW / AUTOSAR modules
  - Det : To report development errors. Should be able to turn OFF (especially for production build)
  - Dem : To report run time error (e.g. report critical error / warning, when Det is turned off: STD_OFF)
  - SchM : For exclusive access (in interrupt context and thread/task context)
- PDK
  - CSL / LLD : Low level API's configure the peripheral and manipulate queues, shared memory & Core ID's

Design ID	DES_CDD_IPC_018
Requirements Covered	MCAL-3699, MCAL-3693, MCAL-3698, MCAL-3697, MCAL-3700

Back To Top

Error Classification

Errors are classified in two categories, development error and runtime / production error.

Development Errors

Type of Error	***Related Error code***	***Value (Hex)***	***Refer Req***
API error return code: Init function failed	CDD_IPC_E_INIT_FAILED	0x01	MCAL-2516
Service API is called without module initialization	CDD_IPC_E_UNINIT	0x02	MCAL-3756
API parameter checking: invalid value	CDD_IPC_E_PARAM_POINTER	0x03	MCAL-2518
API service for initialization is called when already initialized	CDD_IPC_E_ALREADY_INITIALIZED	0x04	MCAL-2515
Error code indicating wrong configuration	CDD_IPC_E_INVALID_CONFIG	0x05	MCAL-2517
Error code indicating sending of an message failed	CDD_IPC_E_SEND	0x06	MCAL-2517
Error code indicating sending of an message failed	CDD_IPC_E_RECEIVE_RETRY	0x07	MCAL-2517
Error code indicating feature is not supported	CDD_IPC_E_NOT_SUPPORTED	0x08	MCAL-2517

Design ID	DES_CDD_IPC_019
Requirements Covered	MCAL-3720, MCAL-3721, MCAL-3722, MCAL-3723, MCAL-3727, MCAL-3729, MCAL-3734, MCAL-3740, MCAL-3756

Error Detection

The detection of development errors is configurable (ON / OFF) at pre-compile time. The switch CddDevErrorDetect shall activate or deactivate the detection of all development errors.

Error notification (DET)

All detected development errors are reported to Det_ReportError service of the Development Error Tracer (DET).

Back To Top

Runtime Errors

The following runtime/production errors shall be detectable by CDD IPC driver

Type of Error	***Related Error code***	***Value (Hex)***

This error shall be reported when Mailbox is not functional	CDD_IPC_E_HARDWARE_ERROR	Defined By Integrator

Error notification (DEM)

All detected run time errors shall be reported to Dem_ReportErrorStatus () service of the Diagnostic Event Manager (DEM).

Design ID	DES_CDD_IPC_020
Requirements Covered	MCAL-3698, MCAL-3693,

Back To Top

Resource Behavior

- **Code Size** : Implementation of this driver shall not exceed 5 kilo lines of code and 1 KB of data section.
- **Stack Size** : Worst case stack utilization shall not exceed 2 kilo bytes.

Design ID	DES_CDD_IPC_021
Requirements Covered	MCAL-3747, MCAL-3748, MCAL-929

Back To Top

Low Level Definitions

This section describes the API supported by the MCAL driver and the requirements covered by each of the API.

MACROS, Data Types & Structures

The sections below lists some of key data structures that shall be implemented and used in driver implementation

Maximum number of channels

Type	Identifier	Comments
uint32	CDD_IPC_CORE_ID_MAX	Defines the maximum number of remote cores supported by this implementation. This macro shall be used to allocate memory (statically) in the driver implementation.

Cdd_IpcMpType

Used to specify the core identifiers, these values shall be generated by the configurator and not explicitly by the user of this module.

Type	Identifier	Comments
uint32	ownProcID	Defines processor ID on which MCAL/AUTOSAR is being hosted
uint32	numProcs	Number of remote processor which with IPC is desired
uint32	remoteProcID	Array of uin32, that specifies the remote processor identifier
uint32	reserved	Reserved for future use

Design ID	DES_CDD_IPC_022
Requirements Covered	MCAL-3668, MCAL-3669, MCAL-3670, MCAL-3671

Cdd_IpcVertIoType

Defines Shared Memories for VRING and VRING OBJECT, these values shall be generated by the configurator and not explicitly by the user of this module.

Type	Identifier	Comments
void *	vertIoRingAddr	Defines address that shall be shared between cores, also refer (**Assumptions**)
uint32	vertIoRingSize	Size in number of bytes
uint32	reserved	Reserved for future use

Design ID	DES_CDD_IPC_023
Requirements Covered	MCAL-3672, MCAL-3673

Cdd_IpcChannelType

Defines logical communication channel between cores, these values shall be generated by the configurator and not explicitly by the user of this module.

Type	Identifier	Comments
uint32	id	Unique identifiers for a channel

uint32	localEp	Local End Point identifier, on which MCAL/AUTOSAR is hosted
uint32	remoteProcId	Remote Processor Identifier
uint32	numMsgQueued	Maximum depth of the queue, that holds received messages
uint32	maxMsgSize	Maximum size of the message that could be received
uint32	reserved	Reserved for future use

Design ID	DES_CDD_IPC_024
Requirements Covered	MCAL-3677, MCAL-3678, MCAL-3679, MCAL-3680, MCAL-3681, MCAL-3682, MCAL-3755

Cdd_IpcConfigType

CDD IPC Configuration type, these values shall be generated by the configurator and not explicitly by the user of this module.

Type	Identifier	Comments
Cdd_IpcMpType	coreIds	Used to specify the core identifiers refer (**Cdd_IpcMpType**)
Cdd_IpcVertIoType	vertIoCfg	VertIO configurations refer (**Cdd_IpcVertIoType**)
uint32	channelCount	Number of communication channels configured by the integrator
Cdd_IpcChannelType *	pChCfg	Pointer to constant, refer (**Cdd_IpcChannelType**)
uint32	reserved	Reserved for future use

Design ID	DES_CDD_IPC_025
Requirements Covered	MCAL-3702, MCAL-3705

Cdd_IpcRegRbValues

Name	Type	Range	Comments
numRegisters	uint32	0 to 0xFFFFFFFF	Will specify number of registers values provided
regValues	uint32	0 to 0xFFFFFFFF	Values of critical registers that's read and provided
reserved	uint32	0	Reserved for future use

Back To Top

API's

Sections below defines the expected API's to part of this implementation

Cdd_IpcNewMessageNotify

Is a function implemented by the application, with prototype as **void Cdd_IpcNewMessageNotify (uint32 commId)** , where commId is the value specified by integrator while creating the communication channel **id**

	Description	***Comments***
Function Name	Cdd_IpcNewMessageNotify	Is a symbolic name, integrators can specify desired name
Syntax	void **Cdd_IpcNewMessageNotify(uint32 commId)**	Shall be implemented by the MCAL consumer
Called Context	Interrupt	This function would be invoked by driver in interrupt context. Also refer **Flow Chart** for implementation of the ISR.
Reentrancy	Non Reentrant	
Parameter in	uint32 commId	commId is the value specified by integrator while creating the communication channel **id**
Return Value	None	NA

Design ID	DES_CDD_IPC_026
Requirements Covered	MCAL-3691, MCAL-3701

Back To APIs

Back To Top

Cdd_IpcNewCtrlMessageNotify

Is a function implemented by the application, with prototype as **void Cdd_IpcNewCtrlMessageNotify (uint32 remoteProcId)** , where remoteProcId is remote processor ID **Specified During Initialization**

	Description	Comments
Function Name	Cdd_IpcNewCtrlMessageNotify	Is a symbolic name, integrators can specify desired name
Syntax	void Cdd_IpcNewCtrlMessageNotify(uint32 remoteProcId)	Shall be implemented by the MCAL consumer
Called Context	Interrupt	This function would be invoked by driver in interrupt context. Also refer **Control End Point**
Reentrancy	Non Reentrant	
Parameter in	uint32 remoteProcId	One of the Remote processor ID **Specified During Initialization**
Return Value	None	NA

Design ID	DES_CDD_IPC_038
Requirements Covered	MCAL-4067, MCAL-4066

Back To APIs

Back To Top

Cdd_IpcInit

	Description	Comments
Service Name	Cdd_IpcInit	First API to be invoked to initialize the module
Syntax	Std_ReturnType **Cdd_IpcInit(void)**	Service for CDD Initialization
Service ID	0x02	
Sync / Async	Sync	
Reentrancy	Non Reentrant	
Parameter in	none	NA
Parameters out	none	NA
Return Value	Standard return type	E_OK or CDD_IPC_E_INIT_FAILED in case of initialization failure id, or CDD_IPC_E_ALREADY_INITIALIZED in case of reinitialization

Design ID	DES_CDD_IPC_027
Requirements Covered	MCAL-3706, MCAL-3707, MCAL-3708, MCAL-3709, MCAL-3710, MCAL-3712, MCAL-3713, MCAL-3714, MCAL-3715, MCAL-3716

Back To APIs

Back To Top

Cdd_IpcDeinit

	Description	Comments
Service Name	Cdd_IpcDeinit	Last API to be invoked to de initialize the module, can be turned OFF **CddDeinitApi**
Syntax	Std_ReturnType Cdd_IpcDeinit (void)	Service for CDD Initialization
Service ID	0x08	
Sync / Async	Sync	
Reentrancy	Non Reentrant	
Parameter in	none	NA
Parameters out	none	NA
Return Value	Standard return type	E_OK

Design ID	DES_CDD_IPC_028
Requirements Covered	MCAL-3688

Back To APIs

Back To Top

Cdd_IpcSendMsg

	Description	Comments
Service	Cdd_IpcSendMsg	Service for sending an message to remote cores

Name		
Syntax	Std_ReturnType Cdd_IpcSendMsg(uint32 chId, void *pBuf, uint32 bufLen)	
Service ID	0x03	
Sync / Async	Sync	
Reentrancy	Non Reentrant	
Parameter in	chId	chId Refers to communication ID specified while configuring this module, refer **chId**
Parameter in	pBuf	Non NULL_PTR that describes the message that has to sent
Parameter in	bufLen	Message length in bytes
Return Value	Standard return type	E_OK on successful transmission, CDD_IPC_E_SEND on error and CDD_IPC_E_UNINIT when initialized

Design ID	DES_CDD_IPC_029
Requirements Covered	MCAL-3717, MCAL-3718, MCAL-3719, MCAL-3720, MCAL-3721, MCAL-3722, MCAL-3723

Back To APIs

Back To Top

Cdd_IpcReceiveMsg

	Description	***Comments***
Service Name	Cdd_IpcReceiveMsg	Service for reception of N bytes of data from remote cores
Syntax	Std_ReturnType Cdd_IpcReceiveMsg(uint32 chId, void *pBuf, uint32 bufLen)	
Service ID	0x04	
Sync / Async	Sync	
Reentrancy	Non Reentrant	
Parameter in	chId	chId Refers to communication ID specified while configuring this module, refer **chId**
Parameter in out	pBuf	Non NULL_PTR that can hold the received message. Call shall ensure sufficient memory is available, shall be greater than or equal to maximum size specified in configuration. Refer **maxMsgSize**
Parameter in	bufLen	Message length in bytes
Return Value	Standard return type	E_OK on successful reception, CDD_IPC_E_RECEIVE_RETRY on no messages, CDD_IPC_E_UNINIT, when uninitialized.

Design ID	DES_CDD_IPC_030
Requirements Covered	MCAL-3724, MCAL-3725, MCAL-3726, MCAL-3727, MCAL-3728, MCAL-3729

Back To APIs

Back To Top

Cdd_IpcAnnounce

	Description	***Comments***
Service Name	Cdd_IpcAnnounce	Used to broadcast capabilities of this core to all other cores, can be turned OFF **CddIpcAnnounceApi**
Syntax	Std_ReturnType Cdd_IpcAnnounce(void *pBuf, uint32 bufLen)	Service broadcast of message to all cores
Service ID	0x05	
Sync / Async	Sync	

Reentrancy	Non Reentrant	
Parameter in	pBuf	Non NULL_PTR that describes the message that has to sent
Parameter in	bufLen	Message length in bytes
Return Value	Standard return type	E_OK on successful transmission and CDD_IPC_E_SEND on error and CDD_IPC_E_UNINIT when initialized. Also check **Constraint**

Design ID	DES_CDD_IPC_031
Requirements Covered	MCAL-3730, MCAL-3731, MCAL-3732, MCAL-3733, MCAL-3734, MCAL-3735

Back To APIs

Back To Top

Cdd_IpcGetVersionInfo

	Description	***Comments***
Service Name	Cdd_IpcGetVersionInfo	Can potentially be turned OFF, via configuration parameter **CddVersionInfoApi**
Syntax	void Cdd_IpcGetVersionInfo(Std_VersionInfoType VersionInfoPtr)	
Service ID	0x01	
Sync / Async	Sync	
Reentrancy	Reentrant	
Parameters out	VersionInfoPtr	A pointer of type Std_VersionInfoType, which holds the read back values
Return Value	None	

Design ID	DES_CDD_IPC_032
Requirements Covered	MCAL-3739, MCAL-3740, MCAL-3741

Back To APIs

Back To Top

Cdd_IpcRegisterReadBack

As noted from previous implementation, the mailbox configuration registers could potentially be corrupted by other entities (s/w or h/w). One of the recommended detection methods would be to periodically read-back the configuration and confirm configuration is consistent. The service API defined below shall be implemented to enable this detection.

	Description	***Comments***
Service Name	Cdd_IpcRegisterReadBack	Can potentially be turned OFF
Syntax	Std_ReturnType **Cdd_IpcRegisterReadBack(Cdd_IpcRegRbValues *RegRbPtr)**	**Cdd_IpcRegRbValues** defines the type, that holds critical values. This service can be turned OFF **CddRegisterReadBackApi**
Service ID	0x07	
Sync / Async	Sync	
Reentrancy	Non Reentrant	
Parameters out	RegRbPtr	A pointer of type **Cdd_IpcRegRbValues**, which holds the read back values
Return Value	Standard return type	E_OK or E_NOT_OK in case of error

The critical register set shall be determined at implementation.

Design ID	DES_CDD_IPC_033
Requirements Covered	MCAL-3736, MCAL-3737, MCAL-3738

Back To APIs

Back To Top

Cdd_IpcReceiveCtrlMsg

	Description	*Comments*
Service Name	Cdd_IpcReceiveCtrlMsg	Service for reception of N bytes of control data from remote cores
Syntax	Std_ReturnType Cdd_IpcReceiveCtrlMsg(uint32 *pRemoteProcId, uint32 *pRemoteEndPt, void *pBuf, uint32 bufLen)	
Service ID	0x09	
Sync / Async	Sync	
Reentrancy	Non Reentrant	
Parameter in out	pRemoteProcId	Holds the remote processor identifier, one of valid remote processors specified while initializing, refer **RemoteProcID**
Parameter in out	pRemoteEndPt	Holds the remote processor end point, that is the originator of this control message
Parameter in out	pBuf	Non NULL_PTR that can hold the received message. Call shall ensure sufficient memory is available, shall be greater than or equal to maximum size specified in configuration. Refer **maxMsgSize**
Parameter in	bufLen	Received message length in bytes
Return Value	Standard return type	E_OK on successful reception, E_NOT_OK on no messages, CDD_IPC_E_UNINIT, when uninitialized and CDD_IPC_E_PARAM_POINTER when any one of the pointer is NULL

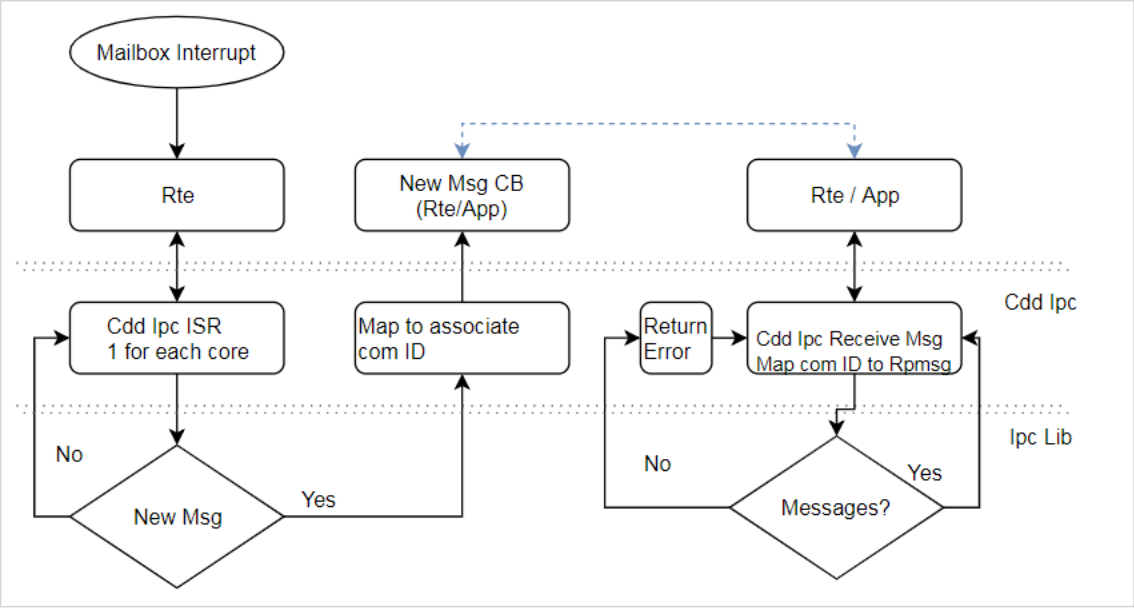
Design ID	DES_CDD_IPC_039
Requirements Covered	MCAL-4068, MCAL-4069, MCAL-4070, MCAL-4071, MCAL-4072

Back To APIs

Back To Top

Cdd_IpcNewMessageNotify ISR

The flow chart below depict the behaviour of ISR on reception of mailbox non-empty interrupt



New Message ISR Flow chart & Reception Service API call

Design ID	DES_CDD_IPC_034
Requirements Covered	MCAL-3691, MCAL-3701

Back To APIs

Back To Top

Global Variables

This design expects that implementation will require to use following global variables.

Variable	Type	Description	Default Value
Cdd_IpcDrvStatus	uint32	Initialization status of the driver is maintained	FALSE
Cdd_IpcDrvObj	Cdd_IpcDriverObjType	IPC driver object, local to the implementation and scope shall be limited to Cdd_Ipc.c	Un defined

Design ID	DES_CDD_IPC_035
Requirements Covered	MCAL-3706

Back To Top

Decision Analysis & Resolution (DAR)

Sections below list some of the important design decisions and rational behind those decision.

Allocation of memory for LocalQ

The memory required to implement queues used to store the received messages could be allocated by user of this module or by this module itself, please refer **LocalQ** for need of local queue

DAR Criteria

Simpler interface and minimize potential errors

Available Alternatives

- **Allocated by user of this module** The user / integrator allocates the required memory and provides a pointer to the allocated memory while configuring this driver
  - **Advantages:**
    - Complete control for the integrators, size and location of the allocated memory
  - **Disadvantages:**
    - Additional configuration parameter
    - Location specified via a global memory
    - Additional checks in the driver required for alignment and null pointer checks
- **Local Allocation** Driver allocates the memory statically, i.e. via an array.
  - **Advantages:**
    - Minimal configuration parameters
    - Alignment can be easily enforced
  - **Disadvantages:**
    - The size of memory is computed and integrator will have to analyze the system memory requirement post compilation of the driver

Decision

To minimize the checks and enhanced ease-of-use, **Local Allocation** is chosen.

Design ID	DES_CDD_IPC_036
Requirements Covered	None

Back To Top

Test Criteria

The sections below identify some of the aspects of design that would require emphasis during testing of this design implementation

- **Boundary Checks**
  - Since variable length messages could be transmitted, tests on message size range shall be performed.
  - Ensure associated error codes are returned on error
- **Latency Measurements**
  - Test cases shall ensure, latencies are measured for transmission and reception
- **Concurrency**
  - Since a core can communicate with multiple cores on different channels, data integrity checks shall be performed when communicating with multiple cores on multiple channels, concurrently.

Back To Top

Document Revision History

Revision	Date	Author	Description	Status
0.1	11 March 2019	Sujith S	First version	Pending Review
0.2	22 March 2019	Sujith S	Addressed review comments	Approved
0.3	01 October 2019	Sujith S	Updated to include control-end point and associated API's	Pending Review